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(19) (CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Self-Adhering Elastic Composite

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ABSTRACT OF THE INVENTION

Disclosed is a self-adhering elastic composite comprising an adhesive material and an elastic material, wherein the elastic material is continuous along a relaxed length of the self-adhering elastic composite, and the self-adhering elastic composite exhibits desired elastic and adhesive properties. Also disclosed is a disposable absorbent product, including the self-adhering elastic composite, intended for the absorption of body fluids.

SELF-ADHERING ELASTIC COMPOSITE

Background of the Invention

Field of the Invention

The present invention relates to a self-adhering, elastic composite which may be used to impart elastic properties to flexible, non-elastic substrates.

Description of the Related Art

Vulcanized rubber or synthetic rubber elastic bands or threads have typically been used to provide elastic properties to flexible substrates by attaching the elastic to the substrate using materials such as thread, yarn, or adhesive in a sewing, weaving, or adhesive process. The attachment of elastic bands to the underlying flexible substrate generally consumes additional materials and manufacturing resources and poses problems in the industry. Natural vulcanized or crosslinked synthetic rubbers are difficult to feed continuously and at high speeds, in view of their tendency to stretch and relax during mechanical processes, resulting in articles with broken elastics, articles having an elastic with too great or too little tension, or articles with partly attached elastics. Further, adhesives which have typically been used in the past to bond elastic bands to a flexible substrate generally have had poor adhesion to the elastic bands resulting in the separation of the elastic during any substantial flexing of the substrate.

For example, it is known to apply an adhesive, in the form of a spray, along the length of continuous elastic bands contacting a continuous substrate web. The elastic bands are generally in a stretched condition while the adhesive is applied in a nonstretched

condition. Alternatively, the stretched elastic bands can be coated with the adhesive prior to contact with the substrate web.

Typical elastic materials are generally crosslinked, three-dimensional networks of vulcanized natural or synthetic rubber. The crosslinked three dimensional structure comprises a reversible energy storing network. Stress applied to the substance results in a strain or deformation of the three dimensional network which stores energy, applied during stress, which can be spontaneously substantially recovered upon the removal of the stress.

Pressure sensitive adhesives, in contrast to elastic materials, generally require a different set of properties. Upon the application of stress or force to a pressure sensitive adhesive, in the form of pressure, the adhesive must deform in order to come into intimate contact through viscous flow with the surface of a substrate in order to form adhesive bonds by van der Waals attraction. In order to preserve the adhesive bond, upon removal of the stress or pressure, the adhesive must not recover from the deformation. Substances that are pressure sensitive adhesives generally exhibit viscous flow and, therefore, inherently do not substantially recover from such deformation.

Elastic materials, therefore, generally have minimal adhesive properties, and pressure sensitive adhesives generally have minimal elastic properties. Commonly available pressure sensitive adhesive or elastic materials do not have the correct balance of properties which would result in a truly suitable self-adhering elastic material, since the molecular properties that result in elasticity are those that commonly result in the absence of adhesive properties. Attempts to prepare a single composition material that may be used as a self-adhering elastic material has generally required a compromise between the desired elastic and adhesive properties. Another problem with such materials is that, upon aging, the material will suffer a high loss of either the elastic or adhesive properties, or both.

A need, therefore, exists for a self-adhering elastic material that has a unique combination of properties combining both substantial elastic and adhesive properties. Such a material should further be capable of being continuously processed and applied to flexible substrates at high speeds using automatic machines. A further need exists for a self-adhering elastic material which, during flex, will resist detachment from the substrate. Another need exists for a self-adhering elastic material having adequate peel force which can be attached with strong bonds to a flexible substrate at high machine speed without breaking. Another need exists for a self-adhering elastic material that substantially retains its elastic and adhesive properties after aging.

Summary of the Invention

The present invention concerns a self-adhering elastic composite exhibiting both substantial elastic and adhesive properties that is highly machine processable and which substantially retains its elastic and adhesive properties with aging.

One aspect of the present invention concerns a self-adhering elastic composite comprising an adhesive material and an elastic material, wherein the elastic material is continuous along a relaxed length of the self-adhering elastic composite, and the self-adhering elastic composite exhibits desired elastic and adhesive properties.

One embodiment of such a self-adhering elastic composite has a relaxed length and comprises an adhesive material attached to an elastic material, wherein the elastic material is continuous along the relaxed length of the self-adhering elastic composite, and wherein the self-adhering elastic composite exhibits the following properties:

a. the ability to be stretched at least about 50 percent of the relaxed length;

b. an aged Creep value that is not more than 25 percent when the self-adhering elastic composite is aged at about 72°F for about 2 weeks when stretched at a 50 percent extension;

c. an aged Creep value that is not more than 25 percent when the self-adhering elastic composite is aged at about 110°F for about 24 hours when stretched at a 50 percent extension;

d. an aged Peel Force value that is not less than about 80 percent of the original Peel Force value when the self-adhering elastic composite is aged at about 72°F for about 2 weeks when stretched at a 50 percent extension; and

e. an aged Peel Force value that is not less than about 80 percent of the original Peel Force value when the self-adhering elastic composite is aged at about 110°F for about 24 hours when stretched at a 50 percent extension.

Another embodiment of such a self-adhering elastic composite has a relaxed length and comprises a first layer attached to a second layer, wherein the first layer comprises an adhesive material, the second layer comprises an elastic material continuous along the relaxed length of the self-adhering elastic composite, and the self-adhering elastic composite exhibits desired elastic and adhesive properties.

Another embodiment of such a self-adhering elastic composite has a relaxed length and comprises an adhesive material matrix attached to and substantially encasing an elastic material continuous along the relaxed length of the self-adhering elastic composite, the self-adhering elastic composite exhibiting desired elastic and adhesive properties.

In another aspect, the present invention concerns a gatherable elastic laminate comprising a gatherable substrate attached to a self-adhering elastic composite wherein the self-adhering elastic composite exhibits desired elastic and adhesive properties.

In another aspect, the present invention concerns a disposable absorbent product comprising a self-adhering elastic composite wherein the self-adhering elastic composite exhibits desired elastic and adhesive properties.

One embodiment of such a disposable absorbent product comprises a liquid-permeable topsheet, a backsheet attached to the liquid-permeable topsheet, an absorbent structure positioned between the topsheet and the backsheet, and a self-adhering elastic composite positioned between the topsheet and the backsheet wherein the self-adhering elastic composite exhibits desired elastic and adhesive properties.

Brief Description of the Drawings

Fig. 1 represents one embodiment of a self-adhering elastic composite of the present invention.

Fig. 2 represents another embodiment of a self-adhering elastic composite of the present invention.

Fig. 3 represents a disposable diaper according to the present invention.

Fig. 4 represents a plot of the stress-strain force measurements of a self-adhering elastic structure sample stretched using a tensile tester.

Detailed Description of the Preferred Embodiments

In one aspect, the present invention is a self-adhering elastic material which is a composite comprising an adhesive material and an elastic material. It has been found that, by using two separate but compatible materials in combination, one an adhesive material and the other an elastic material, it is possible to prepare a self-adhering elastic composite that exhibits improved adhesive and elastic properties as compared to known materials.

As used herein, the terms "self-adhering elastic material", "self-adhering elastic composite", and other related terms are meant to represent a material that exhibits both substantial adhesive and elastic properties such that the self-adhering elastic material can provide elastic properties to a flexible, non-elastic substrate without any need for additional attachment means to attach the

self-adhering elastic material to the flexible, non-elastic substrate.

As used herein, the term "adhesive material" is intended to mean a material that is generally capable of bonding two other materials together. Such bonding may result from the application of a pressure force, in the case of a pressure sensitive adhesive material, or a sufficiently high temperature, in the case of a hot-melt adhesive, to contact and bond the adhesive material to a substrate. Specifically, as used herein, an adhesive material is meant to be a material that exhibits a Peel Force value, as described herein, that is greater than about 300 grams per 25.4 millimeters of width of the adhesive material. Suitably, the adhesive material also exhibits an Initial Modulus value, as described herein, that is between about $1x10^6$ to about $4x10^6$ dynes per square centimeter and a Stress at 50 Percent Extension value, as described herein, that is between about $0.1x10^6$ to about $4x10^6$ dynes per square centimeter.

Materials suitable for use as the adhesive in the present invention may be of any known type, such as a thermoplastic hot-melt adhesive, a reactive adhesive, a pressure sensitive adhesive, or the like, as long as the adhesive material exhibits the properties specified herein. An example of a thermoplastic hot-melt adhesive includes a synthetic rubber-based adhesive based on polystyrene-polybutadiene-polystyrene chemistry and a tackifier based on hydrocarbon chemistry. A description of compositions of hot-melt adhesives can be found, for example, in "CRC Elastomer Technology Handbook", edited by Nicholas P. Cheremisinoff (CRC Press, 1993), Chapter 24, incorporated herein by reference.

Examples of reactive adhesives include crosslinked amine-epoxide compounds or moisture-cured polyurethanes. The chemistry of such reactive adhesives is known to those skilled in the art and may be found, for example, in "Contemporary Polymer Chemistry", by Harry Alcock and Frederick Lampe (Prentice Hall, 1990), incorporated herein by reference.

The adhesive material is beneficially present in the self-adhering elastic composite of the present invention in an amount of from greater than 0 to less than 100 weight percent, suitably from about 1 to about 99 weight percent, and more suitably from about 5 to about 95 weight percent based on the total weight of the adhesive material and the elastic material in the self-adhering elastic composite.

As used herein, the term "elastic material" is intended to mean a material that is generally capable of recovering its shape after deformation when the deforming force is removed. Specifically, as used herein, an elastic material is meant to be a material that exhibits a Peel Force value that is less than about 300 grams per 25.4 millimeters of width of the elastic material and is capable of being stretchable to a stretched, biased length which is at least about 125 percent, that is about 1.25 times, its relaxed, unbiased length, and that will recover at least 40 percent of its elongation upon release of the stretching, elongating force. A hypothetical example which would satisfy this definition of an elastomeric material would be a one (1) inch sample of a material which is elongatable to at least 1.25 inches and which, upon being elongated to 1.25 inches and released, will recover to a length of not more than 1.15 inches. Many elastic materials may be stretched by much more than 25 percent of their relaxed length and many of these will recover to substantially their original relaxed length upon release of the stretching, elongating force. This latter class of materials is generally beneficial for purposes of the present invention. Suitably, the elastic material also exhibits an Initial Modulus value that is between about $3x10^6$ to about $120x10^6$ dynes per square centimeter and a Stress at 50 Percent Extension value that is between about $1x10^6$ to about $20x10^6$ dynes per square centimeter.

The term "recover" relates to contraction of a stretched material upon termination of a biasing force following stretching of the material by application of the biasing force. For example, if a material having a relaxed, unbiased length of one (1) inch were elongated 50 percent by stretching to a length of 1.5 inches, the material would have been elongated 50 percent and would have a

stretched length that is 150 percent of its relaxed length. If this exemplary stretched material contracted, that is, recovered to a length of 1.1 inches after release of the biasing and stretching force, the material would have recovered 80 percent (0.4 inch) of its elongation.

Materials suitable for use as the elastic material herein include diblock, triblock, or multiblock elastomeric copolymers such as olefinic copolymers such as styrene-isoprene-styrene, styrene-butadiene-styrene, styrene-ethylene/butylene-styrene, or styrene-ethylene/propylene-styrene; polyurethanes, such as those available from E. I. Du Pont de Nemours Co., under the trade name Lycra polyurethane; polyamides, such as polyether block amides available from Ato Chemical Company, under the trade name Pebax polyether block amide; or polyesters, such as those available from E. I. Du Pont de Nemours Co., under the trade name Hytrel polyester.

The elastic material is beneficially present in the self-adhering elastic composite of the present invention in an amount of from greater than 0 to less than 100 weight percent, suitably from about 1 to about 99 weight percent, and more suitably from about 5 to about 95 weight percent based on the total weight of the adhesive material and the elastic material in the self-adhering elastic composite.

A number of block copolymers can be used to prepare either the adhesive or the elastic material useful in preparing the self-adhering elastic composite of this invention. As will be appreciated by one skilled in the art, the actual components used, the relative amounts of each component used, and/or the process conditions used to prepare the block copolymer will need to be different so as to separately prepare an adhesive block copolymer material or an elastic block copolymer material that each respectively exhibit the properties desired herein.

Such block copolymers generally comprise an elastomeric midblock portion and a thermoplastic endblock portion. The block copolymers used in this invention generally have a three dimensional physical

crosslinked structure below the endblock portion glass transition temperature (T_g). The block copolymers are also generally thermoplastic in the sense that they can be molted above the endblock T_g, formed, and resolidified several times with little or no change in physical properties (assuming a minimum of oxidative degradation).

One way of synthesizing such block copolymers is to polymerize the thermoplastic endblock portions separately from the elastomeric midblock portions. Once the midblock and endblock portions have been separately formed, they can be linked. Typically, midblock portions can be obtained by polymerizing di- and tri-unsaturated C_4-C_{10} hydrocarbons such as, for example, dienes such as butadiene, isoprene, and the like, and trienes such as 1,3,5-heptatriene, and the like. When an endblock portion A is joined to a midblock portion B, an A-B block copolymer unit is formed, which unit can be coupled by various techniques or with various coupling agents C to provide a structure such as A-B-A, which is believed to comprise two A-B blocks joined together in a tail-to-tail A-B-C-B-A arrangement. By a similar technique, a radial block copolymer can be formed having the formula $(A\text{-}B)_nC$, wherein C is the hub or central, polyfunctional coupling agent and n is a number greater than 2. Using the coupling agent technique, the functionality of C determines the number of A-B branches.

Endblock portion A generally comprises a poly(vinylarene), such as polystyrene, having an average molecular weight between 1,000 and 60,000. Midblock portion B generally comprises a substantially amorphous polyolefin such as polyisoprene, ethylene/propylene polymers, ethylene/butylene polymers, polybutadiene, and the like, or mixtures thereof, having an average molecular weight between about 5,000 and about 450,000. The total molecular weight of the block copolymer is suitably about 10,000 to about 500,000 and more suitably about 200,000 to about 300,000. Any residual unsaturation in the midblock portion of the block copolymer can be hydrogenated selectively so that the content of olefinic double bonds in the block copolymers can be reduced to a residual proportion of less than

5 percent and suitably less than about 2 percent. Such hydrogenation tends to reduce sensitivity to oxidative degradation and may have beneficial effects upon the desired properties of the material being prepared.

Suitable block copolymers used in this invention comprise at least two substantially polystyrene endblock portions and at least one substantially ethylene/butylene midblock portion. Ethylene/butylene typically comprises the major amount of the repeating units in such a block copolymer and can constitute, for example, 70 percent by weight or more of the block copolymer. The block copolymer, if radial, can have three or more arms, and good results can be obtained with, for example, four, five, or six arms. The midblock portion can be hydrogenated, if desired.

Linear block copolymers, such as A-B-A, A-B-A-B-A, or the like, are suitably selected on the basis of endblock content, large endblocks being preferred. For polystyrene-ethylene/butylene-polystyrene block copolymers, a styrene content in excess of about 10 weight percent is suitable, such as between about 12 to about 30 weight percent. With higher styrene content, the polystyrene endblock portions generally have a relatively high molecular weight. A commercially available example of such a linear block copolymer elastic material is a styrene-ethylene/butylene-styrene block copolymer which contains about 13 weight percent styrene units and essentially the balance being ethylene/butylene units, commercially available from the Shell Chemical Company under the trade designation KRATON G1657 elastomeric resin. Typical properties of KRATON G1657 elastomeric resin are reported to include a tensile strength of 3400 pounds per square inch (2×10^6 kilograms per square meter), a 300 percent modulus of 350 pounds per square inch (1.4×10^5 kilograms per square meter), an elongation of 750 percent at break, a Shore A hardness of 65, and a Brookfield viscosity, when at a concentration of 25 weight percent in a toluene solution, of about 4200 centipoise at room temperature.

Both the adhesive material and the elastic material may be in the form of a film, foam, fibrous web, threads, or the like. Suitably,

both the adhesive material and the elastic material are in the form of nonwoven materials. As used herein, the term "nonwoven" is intended to mean that a material has been formed without the use of a weaving process.

A nonwoven film generally has the structure of a continuous sheet of material, with no identifiable, individual fibers or the like. Nonwoven films are known to be able to be prepared by a variety of processes such as, for example, extrusion processes.

A nonwoven foam generally has the structure of being a dispersion of a gas in a liquid or solid. Such foams are generally prepared by the mechanical incorporation of air or another gas into a solution or mixture of the material to be foamed.

A fibrous web generally has the structure of individual fibers or threads which are interlaid, but not in an identifiable, repeatable manner. Nonwoven webs are known to be able to be prepared by a variety of processes such as, for example, meltblowing processes, spunbonding processes, film aperturing processes, and staple fiber carding processes. Nonwoven webs generally have an average basis weight of not more than about 300 grams per square meter and suitably have an average basis weight from about 3 to about 100 grams per square meter.

A nonwoven thread or fiber generally has the structure wherein the length is at least about 10 times greater than the width or radius. Such nonwoven threads or fibers may be shaped or essentially round. Nonwoven threads or fibers are known to be able to be prepared by a variety of processes such as, for example, extrusion processes.

The adhesive material and the elastic material useful in the present invention must be substantially compatible so they may be attached to one another to form a self-adhering elastic composite. As used herein, the term "compatible" is meant to represent that the adhesive material and the elastic material can exist attached in intimate contact with each other for long periods of time with no

substantially adverse affect of one on the other. In particular, the attaching of the elastic material to the adhesive material does not substantially affect the adhesive properties of the adhesive material, and the attaching of the adhesive material to the elastic material does not substantially affect the elastic properties of the elastic material. Furthermore, the adhesive material and the elastic material should be effectively attached to each other such that the two materials may not be easily separated from each other during use of the self-adhering elastic composite. Suitably, the Peel Force value required to separate the adhesive material from the elastic material, in the self-adhering elastic composite of the present invention, will be greater than about 500 grams per linear inch. As such, by attaching together an adhesive material and an elastic material that are compatible, it is possible for the composite to exhibit the desired elastic and adhesive properties as described herein.

The self-adhering elastic composite of the present invention will be a three dimensional structure having a length, a width, and a depth. Since the self-adhering elastic composite will be capable of being stretched, the self-adhering elastic composite will have a relaxed length, width, and depth, respectively, as measured when the self-adhering elastic composite is not under any tension or force, such as a biasing force. The self-adhering elastic composite will also exhibit various stretched lengths, widths, and depths, respectively, as measured when the self-adhering elastic composite is stretched under a tension or force.

In one embodiment of the present invention, the self-adhering elastic composite will comprise at least two layers. At least one layer will comprise an adhesive material. At least one layer will comprise an elastic material. In the instance where the self-adhering elastic structure consists of two layers, a first layer will comprise an adhesive material and will be attached to a second layer comprising an elastic material. Suitably, the first layer will consist essentially of an adhesive material and the second layer will consist essentially of an elastic material.

In such an embodiment, the self-adhering elastic composite is suitably prepared by separately preparing or forming the adhesive material layer and the elastic material layer and then attaching the layers together. Alternatively, such a self-adhering elastic composite may be prepared in a single process step such as by using a multi-layered coextrusion process.

In conventional elastic laminating processes, the adhesive material is typically sprayed or applied onto a pre-stretched elastic material before lamination with a substrate. In these instances, the adhesive material does not substantially contribute to the mechanical properties of the laminate since the adhesive material is not a load bearing member of the laminate. The adhesive material in these instances generally functions solely as an attachment material.

In the present invention, however, the adhesive material, in addition to the elastic material, also acts as a load bearing member since the adhesive material may be substantially stretched along with the elastic material while remaining attached to the elastic material. Hence, in the self-adhering elastic composite of the present invention, the elastic material essentially physically acts as a recoverable spring and the adhesive material essentially physically acts as a viscous dashpot in parallel with the elastic material. Thus, both the adhesive material and the elastic material are load bearing members with the adhesive material being viscous and the elastic material being elastic. As such, the mechanical properties of the self-adhering elastic composite of the present invention are determined by both the adhesive and elastic material components, with the adhesive material also acting as an attachment material to a substrate.

In a beneficial embodiment of the present invention, the self-adhering elastic composite will comprise three layers interlaid on top of each other. The top and bottom layers will comprise an adhesive material and the middle layer will comprise an elastic layer.

Fig. 1 illustrates a self-adhering elastic composite according to such an embodiment. Self-adhering elastic composite 10 includes two adhesive material layers 11 attached to opposite sides of an elastic material layer 12. Both of the adhesive material layers 11 and the elastic material layer 12 are in the form of nonwoven films.

In another embodiment of the present invention, the self-adhering elastic composite will comprise an adhesive material matrix attached to and substantially encasing an elastic material. As used herein, the term "encase" and related terms, are intended to mean that the adhesive material substantially encloses or surrounds the elastic material. Generally, in such an embodiment, the elastic material will be in the form of fibers, threads, or a fibrous web which are encased in an adhesive material matrix.

Such a self-adhering elastic composite of the present invention is suitably prepared by first forming the elastic material and then substantially encasing the elastic material with an adhesive material matrix.

Fig. 2 illustrates a self-adhering elastic composite according to such an embodiment. Self-adhering elastic composite 20 includes an adhesive material matrix 21 and elastic material threads 22. The adhesive material matrix 21 is seen to substantially encase the elastic material threads 22 within the adhesive material matrix 22.

The self-adhering elastic composite is suitably extrudable such that it can be formed into a nonwoven material. A nonwoven self-adhering elastic composite may be in the form of a film, a web, or the like.

It is desirable that the self-adhering elastic composite of the present invention exhibit both desirable elastic and adhesive properties which is in contrast to known materials which generally only exhibit either desirable elastic or desirable adhesive properties.

Elastic properties desired of the self-adhering elastic composite of the present invention include effective stretchability, aged Creep, Initial Modulus, Stress at 50 Percent Extension, and Stress Relaxation values.

The self-adhering elastic composite should exhibit the ability to be stretched so as to be extended at least about 50 percent, suitably at least about 75 percent, more suitably at least about 100 percent, and most suitably at least about 200 percent, and up to about 10,000 percent of the relaxed length of the composite.

The Creep value is meant to represent the increase in relaxed length exhibited by a material after having been extended about 50 percent by stretching. As such, the Creep value is the difference between the relaxed length after about 50 percent extension and the original relaxed length before about 50 percent extension, divided by the original relaxed length, and multiplied by 100 percent to give a value in percent. An aged Creep value is meant to represent the increase in relaxed length exhibited by a material after having been extended about 50 percent by stretching and maintained at the about 50 percent extension for a period of time and under specific temperature conditions.

One suitable aging condition is to maintain the 50 percent extended material at about 72°F (about 22°C) for about 2 weeks, after which the material exhibits an aged Creep value that is suitably not greater than about 25 percent, more suitably not greater than about 20 percent, and most suitably not greater than about 15 percent.

Another suitable aging condition is to maintain the 50 percent extended material at about 110°F (about 43°C) for about 24 hours, after which the material exhibits an aged Creep value that is suitably not greater than about 25 percent, more suitably not greater than about 20 percent, and most suitably not greater than about 15 percent.

As used herein, all percentage extensions are expressed as a percent of the unextended or relaxed length of a material. Thus, 100 percent extension means that the untensioned material has been stretched to twice its relaxed, or untensioned, length.

The Initial Modulus value of a self-adhering elastic composite is meant to represent the amount of force initially needed to stretch the self-adhering elastic composite and, thus, represents the stiffness of the self-adhering elastic composite. It is desired that the self-adhering elastic composite not exhibit an Initial Modulus that is too low such that the self-adhering elastic composite will be too soft and viscous. Also, it is desired that the self-adhering elastic composite not exhibit an Initial Modulus that is too high such that the self-adhering elastic composite causes red markings on the body of a person wearing a disposable absorbent product including the self-adhering elastic composite.

Thus, a self-adhering elastic composite of the present invention generally exhibits an Initial Modulus value that is beneficially from about 3×10^6 to about 120×10^6 dynes per square centimeter, suitably from about 5×10^6 to about 80×10^6 dynes per square centimeter, and more suitably from about 20×10^6 to about 80×10^6 dynes per square centimeter, as measured according to the methods described in the Test Procedures section herein.

The Stress at 50 Percent Extension value of a self-adhering elastic composite is meant to represent the amount of force exerted by the self-adhering elastic composite when it is elongated 50 percent by stretching and, thus, generally represents the donning tension of a disposable absorbent product including the self-adhering elastic composite. It is desired that the self-adhering elastic composite not exhibit a Stress at 50 Percent Extension value that is too low, since such may result in the slipping or falling, for example, of a disposable absorbent product that includes the self-adhering elastic composite. Also, it is desired that the nonwoven sheet not exhibit a Stress at 50 Percent Extension value that is too high, since such may cause the self-adhering elastic composite to exert too much force,

for example, against a wearer of a disposable absorbent product including the self-adhering elastic composite, thus causing redmarking on the wearer.

Thus, the self-adhering elastic composite of the present invention exhibits a Stress at 50 Percent Extension value that is beneficially from about 3×10^6 to about 10×10^6 dynes per square centimeter, suitably from about 3×10^6 to about 9×10^6 dynes per square centimeter, and more suitably from about 4×10^6 to about 7×10^6 dynes per square centimeter, as measured according to the methods described in the Test Procedures section herein.

The Stress Relaxation value of a material is meant to represent the decay or drop in tension exhibited by the material when it is allowed to relax for 20 minutes in an elongated state after having been elongated 50 percent by stretching. It is desired that the self-adhering elastic composite of the present invention not exhibit a Stress Relaxation value that is too high, since such will indicate that the self-adhering elastic composite will lose too much tension after having been subjected to a stretching force and, thus, will not be able to provide sufficient tension to hold a disposable absorbent product in place on a wearer.

Thus, the self-adhering elastic composite of the present invention generally exhibits a Stress Relaxation value that is beneficially less than about 35 percent, suitably less than about 30 percent, and more suitably less than about 25 percent, as measured according to the methods described in the Test Procedures section herein.

Adhesive properties desired of the self-adhering elastic composite of the present invention include effective Peel Force values.

The Peel Force value is meant to represent the amount of force required to detach two materials adhered together. It is desired that the self-adhering elastic composite of the present invention not exhibit a Peel Force value when attached to a non-elastic substrate, such as a gatherable material, that is too low since such will

indicate that the self-adhering elastic composite will not effectively adhere to the non-elastic substrate to which it is attached and may detach during use. Also, it is desired that the self-adhering elastic composite not exhibit a Peel Force value that is too high, since such will generally indicate that the self-adhering elastic composite will exhibit high viscous properties.

Thus, the self-adhering elastic composite of the present invention generally exhibits a Peel Force value, when attached to a non-elastic substrate, that is beneficially greater than about 350 grams per 25.4 millimeter width, suitably greater than about 400 grams per 25.4 millimeter width, and more suitably greater than about 450 grams per 25.4 millimeter width as measured according to the methods described in the Test Procedures section herein.

It is also desirable that the self-adhering elastic composite exhibit desirable aged Peel Force values. An aged Peel Force value is meant to represent the Peel Force value exhibited by a material after having been extended 50 percent by stretching and maintained at the 50 percent extension for a period of time and under specific temperature conditions.

One suitable aging condition is to maintain the 50 percent extended material at about 72°F (about 22°C) for about 2 weeks, after which the material exhibits an aged Peel Force value that is suitably not less than about 80 percent, more suitably not less than about 85 percent, and most suitably not less than about 90 percent, of the Peel Force value of the material prior to such aging.

Another suitable aging condition is to maintain the 50 percent extended material at about 110°F (about 43°C) for about 24 hours, after which the material exhibits an aged Peel Force value that is suitably not less than about 80 percent, more suitably not less than about 85 percent, and most suitably not less than about 90 percent of the Peel Force value of the material prior to such aging.

The self-adhering elastic composite of the present invention may generally be of any size or dimension as long as the self-adhering elastic composite exhibits the desired elastic and adhesive properties as described herein. When used in a disposable absorbent product, a self-adhering elastic composite will typically have dimensions of a width about 0.75 inch (about 1.9 centimeter), a length of about 6 inches (about 15 centimeters), and a depth of about 0.02 inch (about 0.05 centimeter).

The self-adhering elastic composite of the present invention may also be used or combined with other self-adhering elastic materials, with the self-adhering elastic composite of the present invention being used as a separate layer or as an individual zone or area within a larger, composite self-adhering elastic material. The self-adhering elastic composite of the present invention may be combined with other self-adhering elastic materials by methods well known to those skilled in the art, such as by using adhesives, or simply by layering the different materials together and holding together the composite materials with, for example, the self-adhering characteristics of the different materials.

In another aspect of the present invention, it is desired to use a self-adhering elastic composite to prepare an elastic laminate comprising at least one gatherable material attached to at least one self-adhering elastic composite.

Such an elastic laminate may be prepared by tensioning the self-adhering elastic composite so as to elongate it, then attaching the self-adhering elastic composite to at least one gatherable material to form an elastic laminate, and then relaxing the elastic laminate so that the gatherable material is gathered by relaxing the self-adhering elastic composite. Typical conditions for attaching the self-adhering elastic composite to the gatherable material include overlaying the stretched self-adhering elastic composite and the gatherable materials and applying heat and/or pressure to the overlaid materials so as to create bonding sites between the overlaid materials.

Various gatherable materials can be utilized in forming the elastic laminate. Such gatherable materials can include, but are not limited to, non-elastic fibrous webs such as carded non-elastic polyester or non-elastic polypropylene fibrous webs, spunbonded non-elastic polyester or polypropylene non-elastic fibrous webs, non-elastic cellulosic fibrous webs, polyamide fibrous webs, and blends of two or more of the foregoing. Particularly suitable is using the gatherable material as outer cover layers with the self-adhering elastic composite sandwiched as an intermediate layer between the gatherable material layers. Basis weights for the elastic laminate are beneficially between about 4 to about 100 grams per square meter and suitably between about 6 to about 30 grams per square meter.

In another aspect of the present invention, a disposable absorbent product is provided, which disposable absorbent product comprises a liquid-permeable topsheet, a backsheet attached to the topsheet, an absorbent structure positioned between the topsheet and the backsheet, and a self-adhering elastic composite of the present invention wherein the self-adhering elastic composite is typically positioned between the topsheet and the backsheet.

While one embodiment of the invention will be described in terms of the use of a self-adhering elastic composite in an infant diaper, it is to be understood that the self-adhering elastic composite is equally suited for use in other disposable absorbent products known to those skilled in the art.

Fig. 3 illustrates a disposable diaper 1 according to one embodiment of the present invention. Disposable diaper 1 includes a backsheet 2, a topsheet 4, an absorbent structure 6 positioned between the backsheet 2 and the topsheet 4, and a self-adhering elastic composite 8 positioned between the backsheet 2 and the topsheet 4. Self-adhering elastic composite 8 is a self-adhering elastic composite according to the present invention. Specifically, in the illustrated embodiment, self-adhering elastic composite 8 is used as leg elastics positioned on either side of the absorbent 6 of the diaper.

Those skilled in the art will recognize materials suitable for use as the topsheet and backsheet. Exemplary of materials suitable for use as the topsheet are liquid-permeable materials, such as spunbonded polypropylene or polyethylene having a basis weight of from about 15 to about 25 grams per square meter. Exemplary of materials suitable for use as the backsheet are liquid-impervious materials, such as polyolefin films, as well as vapor-pervious materials, such as microporous polyolefin films.

Disposable absorbent products, according to all aspects of the present invention, are generally subjected during use to multiple insults of a body liquid. Accordingly, the disposable absorbent products are desirably capable of absorbing multiple insults of body liquids in quantities to which the absorbent products and structures will be exposed during use. The insults are generally separated from one another by a period of time.

Test Procedures

A commercial tensile tester was used to stretch, at a stretch rate of about 300 millimeters per minute and at a temperature of about 23°C, a material sample, in the form of a film, that was about 3 inches (about 7.6 centimeters) wide, about 100 millimeters long, and of about 0.036 inch (0.09 centimeter) depth, to a stretched extension of about 50 percent of original length, or about 50 millimeters, such that the stretched film had a total stretched length of about 150 millimeters. During such stretching of the film sample, the stretch force, in grams, was measured. Once the desired stretched length was obtained, the film sample was held at the 50 percent stretched extension for about 20 minutes. During these 20 minutes, the stress relaxation force of the film sample was measured. A representative plot of a stress-strain force measurement is shown in Fig. 4. The mechanical properties of the film sample were determined as follows:

Initial Modulus: The Initial Modulus value, in dynes per square centimeter, was taken to be the slope of a tangent (line A in Fig. 4) drawn to the curve of the stress/strain measurements at the origin

(0 percent stretch), normalized with respect to the area of the cross section of the film sample.

Stress at 50 Percent Extension: The Stress at 50 Percent Extension value, in dynes per square centimeter, was determined by simply reading the force value at 50 percent extension of the film sample (point B in Fig. 4), normalized with respect to the area of the cross-section of the film sample.

Stress Relaxation: The Stress Relaxation value, recorded as a percentage, was determined by measuring the difference in stress force for the 50 percent extended film sample between when the sample first reaches the 50 percent stretched extension (point C in Fig. 4) and then after the 20 minute relaxation time period (point D in Fig. 4), dividing by the initial stress for the 50 percent extended film sample (point C in Fig. 4), and then multiplying by 100 percent.

Peel Force: The Peel Force value is a measurement of the adhesive bond strength of a film sample and is measured according to the standardized test method PSTC-1, revised as of August 1989, incorporated herein by reference.

Example

Samples were prepared of elastic laminates consisting of a self-adhering elastic material bonded to two layers of a gatherable substrate.

As a control, films of a conventional self-adhering elastic material, comprising a substantially homogeneous composition of a styrene-isoprene-styrene block copolymer, oils, and tackifying resins and commercially available from Findley Adhesives Inc. under the trade designation H-2209, were used. For each control sample, three layers of this film were combined by overlaying and adhering them to each other so as to prepare a single film having a depth of about 0.036 inch (about 0.9 millimeter) deep.

Sample 1 was prepared by sandwiching and adhering a layer, of a depth of about 0.012 inch (about 0.3 millimeter) of an elastic material, an experimental composition comprising styrene-ethylene/butylene-styrene block copolymer and tackifying resins, available from Findley Adhesives Inc. under the designation E-2, between two layers, each of a depth of about 0.012 inch (about 0.3 millimeter) of a hot-melt adhesive material, comprising styrene-isoprene-styrene block copolymer, oils, and hydrogenated polycyclopentadiene and polyvinyl toluene tackifying resins commercially available from Findley Adhesives Inc. under the trade designation H-2096.

For each sample, several laminates were formed by stretching a sheet of the self-adhering elastic material, having the dimensions of about 1 inch (about 2.5 centimeters) wide, about 3 inches (about 7.6 centimeters) long, and about 0.036 inch (about 0.9 millimeter) deep, by about 300 percent of the original length of the self-adhering elastic material to a total length of about 12 inches (about 30.5 centimeters). The stretched self-adhering elastic material was then sandwiched between two layers of unstretched spun bond material, comprising spunbond polypropylene with a basis weight of about 0.5 ounce per square yard, available from Kimberly-Clark Corporation, and bonded together by pressing the laminate with a 5 pound (2.3 kilogram) roller. The laminate was then allowed to relax. Both the control sample and Sample 1 laminates exhibited stretch of about 280 percent such that the relaxed laminate had a total length of about 3.2 inches (about 8.1 centimeters).

A 3 inch (about 7.6 centimeter) section was marked off on each laminate to be used for measurement purposes. The laminate samples were mounted on cardboard backing by stapling the ends of the laminates in a fixed position on the cardboard backing while the 3 inch marked section of each laminate was stretched to a 50 percent extension such that the stretched 3 inch section had a total length of about 4.5 inches (about 11.4 centimeters). One set of laminate samples was allowed to age at about 72°F (about 22°C) for about 2 weeks. A second set of laminate samples was allowed to age at about 110°F (about 43°C) for about 24 hours.

After aging, the laminate samples were removed from the cardboard backing and allowed to relax for about one-half hour before testing for adhesive and elastic properties. Two inch long sections of each laminate sample were obtained and tested on a standard tensile tester, commercially available from Sintech Company.

The film samples were then measured for aged Creep values. The Control sample exhibited an aged Creep value, for aging at about 72°F for about 2 weeks when stretched at a 50 percent extension, of about 16 percent and an aged Creep value, for aging at about 110°F for about 24 hours when stretched at a 50 percent extension, of about 40 percent.

Sample 1 exhibited an aged Creep value, for aging at about 72°F for about 2 weeks when stretched at a 50 percent extension, of about 16 percent and an aged Creep value, for aging at about 110°F for about 24 hours when stretched at a 50 percent extension, of about 10 percent.

For each of the tested laminates, the Peel Force value exceeds the Tensile Strength of the laminates.

Those skilled in the art will recognize that the present invention is capable of many modifications and variations without departing from the scope thereof. Accordingly, the detailed description and examples set forth above are meant to be illustrative only and are not intended to limit, in any manner, the scope of the invention as set forth in the appended claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS

1. A self-adhering elastic composite having a relaxed length and comprising an adhesive material attached to an elastic material, wherein the elastic material is continuous along the relaxed length of the self-adhering elastic composite, and wherein the self-adhering elastic composite exhibits the following properties:

   a. the ability to be extended at least about 50 percent of the relaxed length;
   b. an aged Creep value that is not greater than about 25 percent when the self-adhering elastic composite is aged at about 72°F for about 2 weeks when extended about 50 percent;
   c. an aged Creep value that is not greater than about 25 percent when the self-adhering elastic composite is aged at about 110°F for about 24 hours when extended about 50 percent;
   d. an aged Peel Force value that is not less than about 80 percent of the original Peel Force value when the self-adhering elastic composite is aged at about 72°F for about 2 weeks when extended about 50 percent; and
   e. an aged Peel Force value that is not less than about 80 percent of the original Peel Force value when the self-adhering elastic composite is aged at about 110°F for about 24 hours when extended about 50 percent.

2. The self-adhering elastic composite of claim 1 wherein the adhesive material is present in the self-adhering elastic composite in an amount of from greater than 0 to less than 100 weight percent, and the elastic material is present in the self-adhering elastic composite in an amount of from greater than 0 to less than 100 weight percent, based on the total weight of the adhesive material and the elastic material in the self-adhering elastic composite.

3. The self-adhering elastic composite of claim 1 wherein the adhesive material is prepared from a block copolymer.

4. The self-adhering elastic composite of claim 1 wherein the adhesive material exhibits an Initial Modulus value that is between about $1x10^4$ to about $4x10^4$ dynes per square centimeter and a Stress at 50 Percent Extension value that is between about $0.1x10^4$ to about $4x10^4$ dynes per square centimeter.

5. The self-adhering elastic composite of claim 1 wherein the adhesive material is a thermoplastic hot-melt adhesive, a reactive adhesive, or a pressure sensitive adhesive.

6. The self-adhering elastic composite of claim 1 wherein the adhesive material is a film, a foam, a fibrous web, or a thread.

7. The self-adhering elastic composite of claim 1 wherein the elastic material exhibits an Initial Modulus value that is between about $3x10^4$ to about $120x10^4$ dynes per square centimeter and a Stress at 50 Percent Extension value that is between about $1x10^4$ to about $20x10^4$ dynes per square centimeter.

8. The self-adhering elastic composite of claim 1 wherein the elastic material is prepared from a block copolymer.

9. The self-adhering elastic composite of claim 1 wherein the elastic material is a film, a foam, a fibrous web, or a thread.

10. The self-adhering elastic composite of claim 1 wherein a Peel Force value required to separate the adhesive material from the elastic material in the self-adhering elastic composite is greater than about 500 grams per linear inch.

11. The self-adhering elastic composite of claim 1 wherein the self-adhering elastic composite is a film or a fibrous web.

12. The self-adhering elastic composite of claim 1 wherein the self-adhering elastic composite exhibits the ability to be extended at least about 200 percent of the relaxed length.

13. The self-adhering elastic composite of claim 1 wherein the self-adhering elastic composite exhibits an aged Creep value that is not greater than about 20 percent, when the self-adhering elastic composite is aged at about 72°F for about 2 weeks when extended about 50 percent, and an aged Creep value that is not greater than about 20 percent when the self-adhering elastic composite is aged at about 110°F for about 24 hours when extended about 50 percent.

14. The self-adhering elastic composite of claim 1 wherein the self-adhering elastic composite exhibits an aged Peel Force value that is not less than about 85 percent of the original Peel Force value, when the self-adhering elastic composite is aged at about 72°F for about 2 weeks when extended about 50 percent, and an aged Peel Force value that is not less than about 85 percent of the original Peel Force value when the self-adhering elastic composite is aged at about 110°F for about 24 hours when extended about 50 percent.

15. The self-adhering elastic composite of claim 1 wherein the self-adhering elastic composite exhibits an Initial Modulus value that is from about $3x10^4$ to about $120x10^4$ dynes per square centimeter, a Stress at 50 Percent Extension value that is from about $3x10^4$ to about $10x10^4$ dynes per square centimeter, and a Stress Relaxation value that is beneficially less than about 35 percent.

16. A self-adhering elastic composite having a relaxed length and comprising a first layer attached to a second layer, wherein the first layer comprises an adhesive material, the second layer comprises an elastic material continuous along the relaxed length of the self-adhering elastic composite, and the self-adhering elastic composite exhibits the following properties:

a. the ability to be extended at least about 50 percent of the relaxed length;

b. an aged Creep value that is not greater than about 25 percent when the self-adhering elastic composite is aged at about 72°F for about 2 weeks when extended about 50 percent;

c. an aged Creep value that is not greater than about 25 percent when the self-adhering elastic composite is aged at about 110°F for about 24 hours when extended about 50 percent;

d. an aged Peel Force value that is not less than about 80 percent of the original Peel Force value when the self-adhering elastic composite is aged at about 72°F for about 2 weeks when extended about 50 percent; and

e. an aged Peel Force value that is not less than about 80 percent of the original Peel Force value when the self-adhering elastic composite is aged at about 110°F for about 24 hours when extended about 50 percent.

17. A self-adhering elastic composite having a relaxed length and comprising an adhesive material matrix attached to and substantially encasing an elastic material continuous along the relaxed length of the self-adhering elastic composite, the self-adhering elastic composite exhibiting the following properties:

a. the ability to be stretched at least about 50 percent of the relaxed length;

b. an aged Creep value that is not more than 25 percent when the self-adhering elastic composite is aged at about 72°F for about 2 weeks when stretched at a 50 percent extension;

c. an aged Creep value that is not more than 25 percent when the self-adhering elastic composite is aged at about 110°F for about 24 hours when stretched at a 50 percent extension;

d. an aged Peel Force value that is not less than about 80 percent of the original Peel Force value when the self-adhering elastic composite is aged at about 72°F for about 2 weeks when stretched at a 50 percent extension; and

e. an aged Peel Force value that is not less than about 80 percent of the original Peel Force value when the self-adhering elastic composite is aged at about 110°F

for about 24 hours when stretched at a 50 percent extension.

18. A gatherable elastic laminate comprising a gatherable substrate attached to a self-adhering elastic composite, wherein the self-adhering elastic composite has a relaxed length and comprises an adhesive material attached to an elastic material, wherein the elastic material is continuous along the relaxed length of the self-adhering elastic composite, wherein the self-adhering elastic composite exhibits the following properties:

a. the ability to be stretched at least about 50 percent of the relaxed length;

b. an aged Creep value that is not more than 25 percent when the self-adhering elastic composite is aged at about 72°F for about 2 weeks when stretched at a 50 percent extension;

c. an aged Creep value that is not more than 25 percent when the self-adhering elastic composite is aged at about 110°F for about 24 hours when stretched at a 50 percent extension;

d. an aged Peel Force value that is not less than about 80 percent of the original Peel Force value when the self-adhering elastic composite is aged at about 72°F for about 2 weeks when stretched at a 50 percent extension; and

e. an aged Peel Force value that is not less than about 80 percent of the original Peel Force value when the self-adhering elastic composite is aged at about 110°F for about 24 hours when stretched at a 50 percent extension.

19. A disposable absorbent product comprising a liquid-permeable topsheet, a backsheet attached to the liquid-permeable topsheet, an absorbent structure positioned between the liquid-permeable topsheet and the backsheet, and a self-adhering elastic composite positioned between the liquid-permeable topsheet and the backsheet, wherein the self-adhering elastic composite has a relaxed length and comprises an

adhesive material attached to an elastic material, wherein the elastic material is continuous along the relaxed length of the self adhering elastic composite, wherein the self-adhering elastic composite exhibits the following properties:

a. the ability to be stretched at least about 50 percent of the relaxed length;

b. an aged Creep value that is not more than 25 percent when the self-adhering elastic composite is aged at about 72°F for about 2 weeks when stretched at a 50 percent extension;

c. an aged Creep value that is not more than 25 percent when the self-adhering elastic composite is aged at about 110°F for about 24 hours when stretched at a 50 percent extension;

d. an aged Peel Force value that is not less than about 80 percent of the original Peel Force value when the self-adhering elastic composite is aged at about 72°F for about 2 weeks when stretched at a 50 percent extension; and

e. an aged Peel Force value that is not less than about 80 percent of the original Peel Force value when the self-adhering elastic composite is aged at about 110°F for about 24 hours when stretched at a 50 percent extension.

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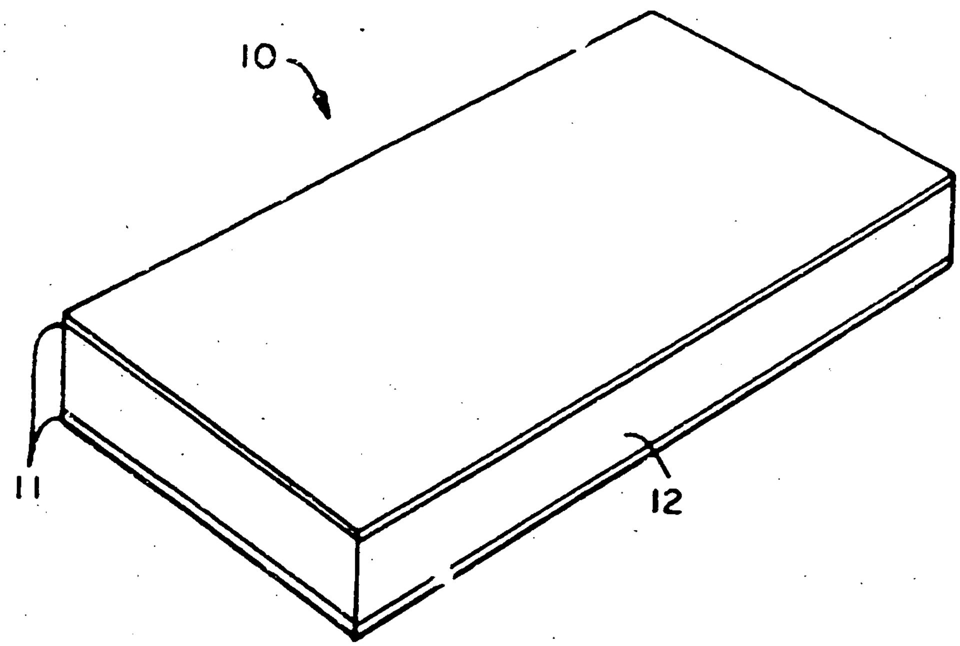

FIG. 1

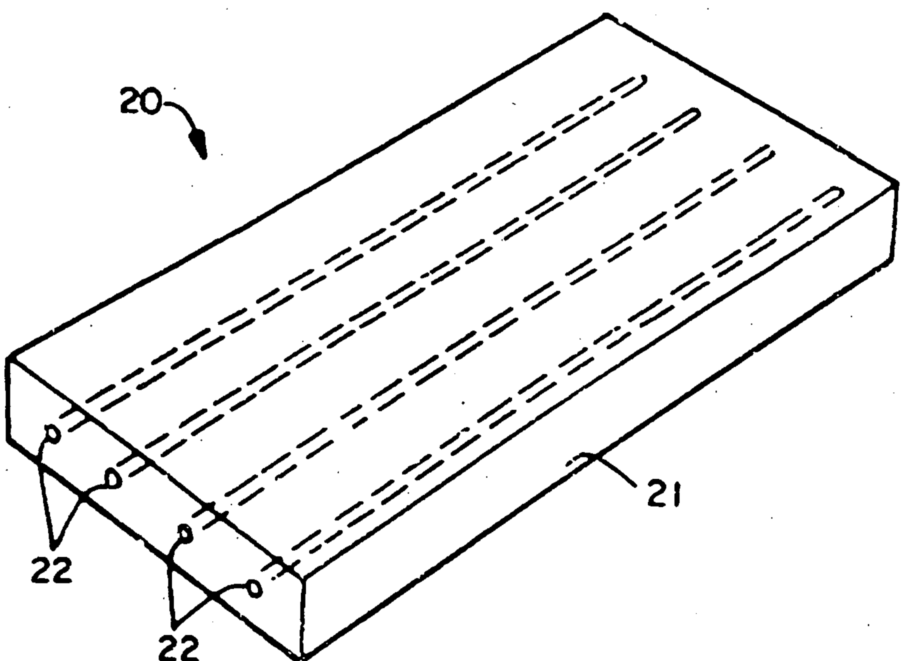

FIG. 2

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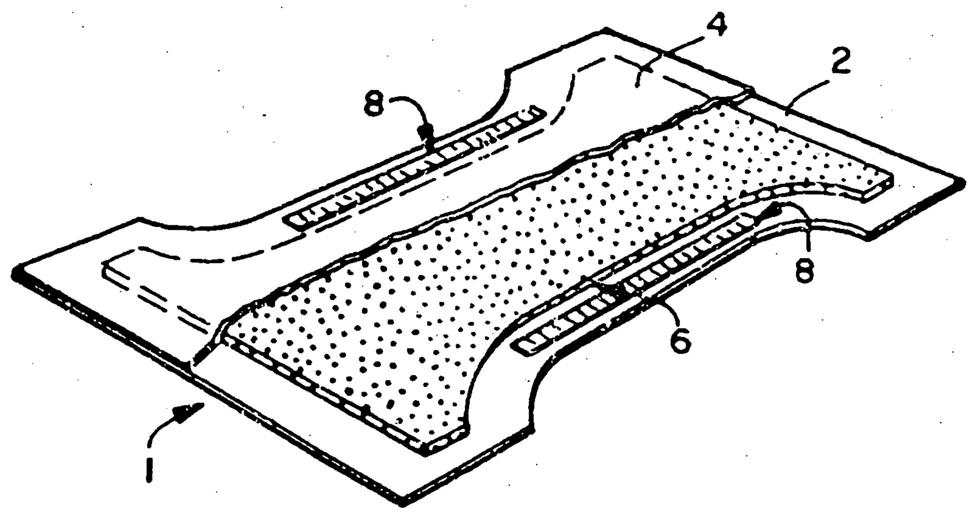

FIG. 3

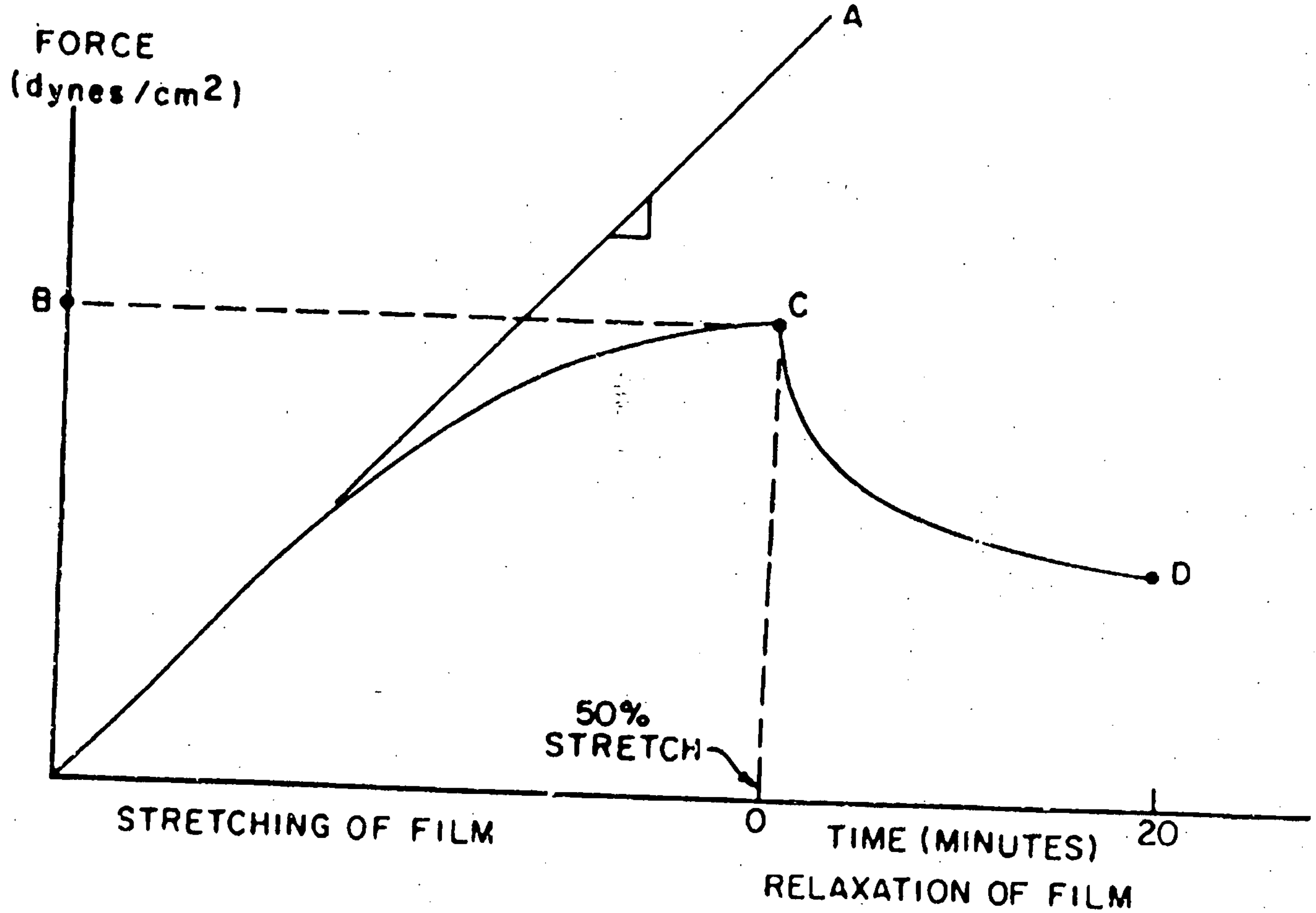
FORCE
(dynes /cm2)
A
B
C
D
50%
STRETCH
STRETCHING OF FILM
0
TIME (MINUTES)
20
RELAXATION OF FILM

FIG. 4

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